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ABSTRACT

This study was designed to investigate the effects of peer teaching on mathematics achievement, nonverbal reasoning, and attitudes of students teaching and being taught by this method. The methods of selecting and training peer teachers, and the special mathematics curriculum used, were those developed by Louis Schell. Students participating attended four junior high schools with large percentages of minority group students. Four instructional patterns were compared. In each group seventh-grade classes were taught by their regular teachers on three days; on the remaining two days they were taught by (1) ninth-grade peer teachiers, (2) a mathematics specialist, (3) an exchange teacher, or (4) the regular teacher. Pre- and post-testing involved an achievement measure of basic skills, three nonverbal reasoning tests, and an attitude measure. Dunn's test was used to test hypotheses concerning change in these variables. Results indicated that students taught by peer teachers or by their regular teachers achieved more than those taught by specialists or exchange teachers. On two nonverbal measures peer-taught students scored higher than at least one comparison group. There were no differences on the attitudinal measure. Comparison of peer teachers with a control group on these measures yielded no differences. (SD)

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EFFECTIVENESS OF SCHELL'S PEER TEACHING PROGRAM IN MATHEMATICS FOR JUNIOR HIGH SCHOOL STUDENTS

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INTRODUCTION

The purpose of this paper is to present the results of a study designed to determine the impact of peer teaching as implemented in the program Alternatives Through Peer Teaching. Peer or cross-age teaching involves students instructing whole classrooms of other students. It is an extension of peer tutoring which is a situation in which children teach children on a one-to-one basis.

DESCRIPTION OF PROGRAM

The peer teaching program, the methods of selecting and training the peer teachers, and the special mathematics curriculum were designed by Louis Schell of The Lawrence Hall of Science at the University of California at Berkeley. The program, in operation since 1971, has involved over 5,000 students in the Berkeley and Oakland schools. Peer teachers instruct for the full class period two days per week and have total responsibility for presenting material, maintaining discipline, and assigning and correcting homework and tests. The peer teachers teach a conceptually oriented curriculum that is used as a vehicle for introducing remedial and basic skill problems. The curriculum explores the algebraic properties of sequences and series and develops related theorems.

Briefly the program is implemented as follows: At the beginning of the school year, ninth grade students volunteer and/or are recommended for peer teaching. Usually the following kinds of students are involved as peer teachers: those

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students who have some motivation to work but whose academic work is marginal--students who might easily fail and not complete school if neglected or who would not fail if given extra attention; those students who are bright but who are underachievers due to boredom or lack of interest in school. All candidates are screened in a 2 - 3 week program for their potential to learn and teach mathematics. The screening program is designed to single out those students who have a) a strong presence b) the ability or potential to teach by asking questions c) a good knowledge of basic arithmetic skills and d) evidence of dependability. Peer teacher trainers, math specialists who have advanced degrees in mathematics, select and train peer teachers and work closely with them throughout the school year. During the first month of the school year these specialists prepare the peer teachers for the classroom by helping them develop their own teaching style and providing them with supplemental information about the material they are to teach. Throughout the rest of the school year the math specialists aid peer teachers in dealing with classroom problems, in refining their teaching methods, and in developing their own materials, methods and style. In this study peer teachers taught classrooms of seventh grade students two days per week. The other three days they spent with the math specialists while the seventh graders had their usual classroom teacher and routine. The regular classroom teachers were present when the peer teachers taught and conferred with them and the math specialists frequently to coordinate presentation of curriculum, share information about particular students and assist the peer teachers in handling specific problems that might arise.

OBJECTIVES

The purpose of this study was to ascertain the potential benefits of peer teaching of mathematics for all students involved. Specifically the study focused on the following hypotheses:

1. Students taught by peer teachers will show greater achievement in mathematics than comparison students.

2. Students taught by peer teachers will show greater increases in nonverbal reasoning than comparison students.

3. Students taught by peer teachers will show greater increment in achievement motivation, self-concept and other attitudinal measures than comparison students.

4. The peer teachers themselves will show greater increases in mathematics achievement, nonverbal reasoning, and positive school related attitudes than a comparison group of students.

METHODOLOGY

Twenty-four ninth grade students were trained to teach basic skills and an abstract mathematics curriculum to whole classes of seventh grade students two days a week. Peer teaching was compared to three other conditions which involved a) mathematics specialists teaching the same curriculum for the same period of time to a comparable group of seventh grade classes; b) exchange teaching in which regular teachers exchanged classes two days per week and taught the standard curriculum; and c) regular teachers who taught a standard curriculum five days per week. Thus there are four conditions: in three of the conditions, a regular teacher taught for three days per week and a peer teacher, math specialist, or exchange teacher taught for two days per week. In the fourth condition, the same teacher taught all five days.

If the mathematics curriculum were the crucial factor, the peer teachers and math specialists should produce greater benefit to their students than either type of regular classroom teacher. If peer teaching provided some additional benefit, students taught by peer teachers should score higher on the test instruments than students taught by math specialists. If peer teaching were beneficial but changing teachers were detrimental, students taught by peer teachers should do better

on the instruments than students taught by exchange teachers. Thus the design of the study provides the possibility of examining the effects of the special math curriculum, the effects of being taught by peers rather than adults, and the effect of having two classroom teachers, one two days a week and the other for three days.

A total of 34 classrooms from four junior high schools in Oakland, California participated in the study. The seventh grade students and the ninth grade peer teachers were primarily minority students. The peer teaching condition had approximately 260 students; the math specialist condition had 75; the exchange teachers had 50; and the regular teacher condition had 250 students.

A battery of tests was group administered to all students in the Fall and Spring of the 1973-74 school year. The instruments used in the study were the following:

1. Comprehensive Test of Basic Skills (CTBS) - Mathematics subtest
2. Primary Mental Abilities (PMA)-Spatial Reasoning subtest
3. Raven Progressive Matrices
4. Cattell Culture Fair Intelligence Test - Subtest One
5. You and School - a specially constructed 40 item questionnaire covering attitude toward school, toward self, toward peer teaching math, achievement motivation, responsibility for academic achievement, and sex role sterotyping.

Analyses were carried out for each of the above dependent variables on the pretest scores. When there were no differences among the conditions on the pretest for each variables, posttest scores were used to test the hypotheses. In those cases where initial differences existed on the pretest, difference scores were analyzed.

Because there was reason to believe that the classrooms were widely different irrespective of experimental condition, the classroom was preserved as the unit of analysis. A priori Dunn comparisons were used to examine differences among the conditions on each variable. The following comparisons were tested through the use of Dunn contrasts:

1. Peer Teaching condition vs. Math Specialist condition
2. Peer Teaching condition vs. Teacher Exchange condition
3. Peer Teaching condition vs. Regular Teacher condition
4. Peer Teaching + Math Specialist vs. Teacher Exchange condition + Regular Teacher condition

All tests were made to control the significance level at .05.

To analyze sex differences, the classroom as a unit of analysis had to be abandoned because the number of cases would have been too drastically reduced in many of the cells. Dunn's contrasts were used to test for possible sex differences.

The design became slightly more complex with the unanticipated switching of seventh grade students from one condition to another in midyear. Since there are no known basis for selection of students to be switched, we assumed that the switched group was a random selection of the entire sample. However, the data were processed separately for those students who remained in the same condition for the entire year (Pure Sample) and those who were switched in midyear (Switched Sample). Results from students who switched conditions (N=100) about 20% of the sample were not necessarily consistent with the results for the Pure Sample although very few were statistically reliable. The rest of this discussion will focus on the findings for the Pure Sample.

RESULTS

Hypothesis 1: Students taught by peer teachers will show greater achievement in mathematics than comparison students.

Because of initial differences among the conditions on the pretest, the diffence scores were used in the analysis. Examination of the total math subtest score (see Table 1) reveals that students taught by peer teachers showed comparable gains in mathematics achievement to students taught by regular teachers (about one year's growth). Students taught by peer teachers showed significantly greater gains than students taught by math specialists or exchange teachers. Hypothesis 1 is in general supported.

Hypothesis 2: Students taught by peer teachers will show greater increases in nonverbal reasoning than comparison students. The PMA, Raven, and Cattell were instruments used to test this hypothesis. There were no differences among the four conditions on the pretest on any of these variables. Therefore posttest scores were examined to look for differences among the groups. (See Table 1)

On the PMA, students in the peer teaching condition scored comparably to students taught by math specialists and significantly higher than students in the other two comparison groups. It may be that the special math curriculum facilitated development of spatial reasoning ability.

For the Raven, students taught by peer teachers scored comparably to students taught by exchange teachers or math specialists and significantly higher than students taught by regular teachers. However, students in all conditions did poorer on the posttest than on the pretest. Perhaps students were not as motivated on the pretest as they were on the original testing.

On the Cattell, there were no differences at all among the groups on the posttest.

Thus, in general Hypothesis 2 is supported. On 2 out of 3 measures of nonverbal reasoning, students of peer teachers scored significantly higher than at least one comparison group.

Hypothesis 3: Students taught by peer teachers will show greater increments in achievement motivation, self-concept and other attitudinal measures than comparison students. An attitudinal questionnaire was created from other existing affective instruments. There were no differences among the conditions on the pretest or posttest total scores. In addition an examination of the subscales of the attitude questionnaire revealed no differences among the conditions. Hypothesis 3 is not supported. It may be, however, that the instrument was not sensitive enough to pick up any affective changes. The correlations among the items were very low suggesting a lot of noise variance within the system. Also we may have been optimistic in expecting affective change; changes in attitudes are difficult to effect within the school system.

There were no strong and consistent sex differences found. In general, the positive effects of peer teaching are more consistent for female students than for males. However, male students were more responsive than females to the type of peer teaching and the sex of the peer teachers. Specifically, males showed significantly larger gains on the CTBS from having two peer teachers than from having only one, and in addition, males showed larger gains on the Cattell from being taught by female than by male peer teachers.

Hypothesis 4: The peer teachers themselves will show greater increases in mathematics achievement, nonverbal reasoning and positive school related attitude than a comparison group of students.

The comparison group was composed of those students who volunteered and/or were recommended for peer teaching but who were not selected by the math specialists to be peer teachers. The selection of peer teachers from the larger group was not as random as one would have liked, but rather depended on the choices of the math specialists and also on the individual desires of the students who could

decide whether they wished to teach. Both the peer teachers and the comparison students were administered the same battery of tests listed above as the seventh graders. No differences between the peer teachers and their ninth grade comparisons were found on any of the cognitive tests. However, the female peer teachers' attitudes and traits relevant to school achievement improved significantly more than the comparison group.

CONCLUSION

The results of this study have shown peer teaching to be a viable educational alternative. Students taught by peer teachers did as well as or better than students in the other three conditions on all the dependent variables. In contrast with results found for peer tutoring, there was no evidence in this study that the peer teachers showed greater gains in math related abilities and skills than students being taught.

Schell feels that the results of this study lead to two important implications: 1) peer teaching can be used to reduce or maintain present pupil-teacher ratios and to create classes built around small group instruction; 2) there are potential cost savings in addition to the benefits derived by the students if instructional programs can incorporate peer teaching into them.

The results of this study can be interpreted from a theoretical perspective. The peer teachers were of the same race and social environment as their students and therefore were not too remote from the students themselves to serve as role models. Also, the peer teachers were in effect publicly rewarded for their achievement by being given the special role of teacher and this too may have served to increase modeling effectiveness. Finally, peer teachers were conversant in subcultural vernacular and knew how to communicate with and interest students beyond the means of the middle calss teacher regardless of race or math training.

Further research is needed to examine the long term effects of peer teaching and the impact of peer teaching in other subjects. But this study has shown peer teaching to be a worthwhile educational option that can be implemented at the classroom level.

TABLE 1

TABLE OF MEANS AMONG CONDITIONS

TEST	PEER TEACHING CONDITION	MATH SPECIALIST CONDITION	EXCHANGE TEACHER CONDITION	REGULAR TEACHER CONDITION
1. CTBS (in grade equivalents)				
pretest	5.35	5.11	4.13	5.21
posttest	6.33	5.06	4.32	6.24
difference	.98 *	-.05 *	.19 *	1.03
2. PMA (50 points possible)				
pretest	21.56	20.08	18.86	17.97
posttest	30.02 *	29.05	22.23 *	25.23 *
difference	8.46	8.97	3.37	7.26
3. Raven (28 points possible)				
pretest	16.48	16.46	16.61	15.72
posttest	15.24 *	14.53	14.50	14.24 *
difference	-1.25	-1.93	-2.11	-1.48
4. Cattell (1[illegible] points possible)				
pretest	6.63	6.71	6.61	6.66
posttest	7.98	7.91	7.97	7.79
difference	1.35	1.20	1.36	1.13
5. You & School (170 points possible)				
pretest	115.84	116.84	117.17	116.72
posttest	118.64	116.54	118.59	117.94
difference	2.80	-.30	1.42	1.22
Total Number of Classrooms	14	4	2	14

*$p < .05$